Energy Efficiency in Industrial Lighting

FACT SHEET

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Background

Many lighting choices exist for industrial settings. Knowing the strengths and weakness of each lamp type will aid in the selection of an energy efficient lamp that meets the needs of a facility. This fact sheet provides descriptions of common lamp types along with basic advantages and disadvantages as they relate to input wattage, efficacy/efficiency, cost, rated life, size, color rendering temperature and more.

Common Terms

Lamp – lighting source, such as light bulbs

Lumen – a unit of luminous flux; quantity of light

Luminaire – complete lighting fixture with bulbs and, if necessary, the ballasts

Ballast – a piece of equipment used to transform and control electric power into a light, specially designed for electrical characteristics of a lamp. Ballast types from most to least efficient are: electronic, hybrid and magnetic.

Efficacy – the ratio of light output (lumens) to input power (watts) stated in lumens per watt (lpw)

Footcandle – the amount of light in a one square foot space exactly one foot from a standard candle

Strengths/Weaknesses of Lighting Types

Incandescent

Incandescent lamps are constructed with a tungsten filament suspended inside a glass bulb filled with inert gas. These lamps come in a variety of shapes/sizes and are commonly seen in many households.

\+ Low cost; excellent color rendition; start instantly; inexpensive dimming; small size; good for focusing light; simple maintenance.

\- Less than 10 percent of input energy goes to producing light with the rest going to heat and adding to cooling load, low efficacy of under 20 lpw; relatively short useful life dependent on voltage; filament sensitive to movement shock and vibration; bulb can get hot during operation; must be properly shielded to avoid glare.

Halogen incandescent lamps contain filament in a quartz tube (filament tube) and operate in mostly an iodine or bromine fill gas. Halogen incandescent lamps can have an efficacy of 35 lpw when the filament tube has an "IR" coating that reflects heat back to the filament. Most ratings are reflectorized (PAR and R) lamps that are used for display lighting. Some (not IR) are used in indoor industrial HID luminaries for standby lighting if HID lamp drops out (see HID lamps).

Fluorescent

Fluorescent lamps contain mercury vapor and other gases. Ultraviolet light is emitted and converted to visible light through the phosphor coating on the inside of the glass tube. Fluorescent lamps are four to five times more efficient than incandescent lamps and come in a wide range of sizes– typically circular, straight or "U" shaped. Recent developments in the color of these lamps allow them to closely duplicate incandescent coloring. Fluorescent lights can be seen in residential, commercial and industrial applications. Efficiency of these lamps increases slightly with length (8-foot is more efficient than 4-foot) and with a decrease in tube diameter (one-inch diameter T-8 lamp is more efficient than a 1.5 inch T-12 lamp). Efficacy is in the average of 30 to 80 lpw.

Compact fluorescent lamps (CFLs) can be installed directly into an incandescent socket when they are configured with an adaptor module that has a screw base and contains an electronic ballast. The tubes of CFLs appear bent several times or bent in the shape of a corkscrew. These lamps last seven to 10

times longer than incandescent lamps and use a quarter of the electricity.

+ Inexpensive; 16 to 20 percent of input energy becomes visible light; long life, averaging from 6,000 to more than 20,000 hours, but lifespan is affected by the number of hours cycles on and off; available in a range of color temperatures and rendering; relatively insensitive to change in voltage; cooler operation.

- Require large and relatively expensive fixtures with heavy ballast; dimming requires special, expensive ballasts; magnetic ballast can be noisy; lumen output drops at low temperatures; special ballasts are required to start at low temperatures; focusing light is not possible.

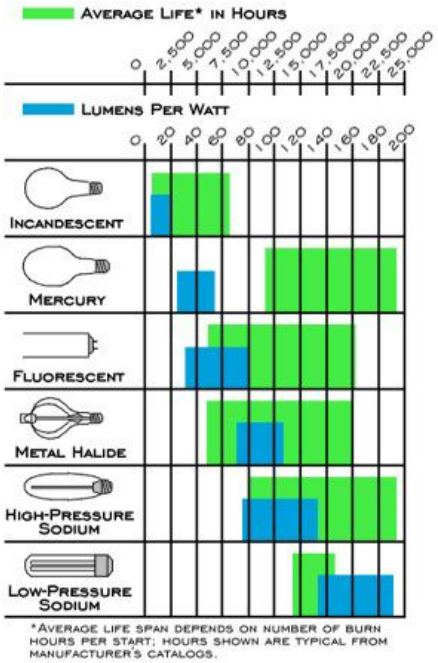
High Intensity Discharge (HID)

The interaction of an electric arc and the gases in a small bulb creates a high amount of light in a small package when compared to fluorescent and incandescent lamps. HID lamps are commonly used when high levels of light are required over large areas and efficiency and long life are important, as in gymnasiums, warehouses, parking lots, etc.

The three main types of HID lamps: mercury vapor (MV), metal halide (MH), and high pressure sodium (HPS).

+ Highly efficacious; range of color temperature and rendering; long life.

- Require ballast; if power is lost the arc tube must cool to a given temperature before the arc can restrike; require a few minutes to reach full light output; generally more expensive.



Courtesy Tri-State Generation and Transmission Association Inc. (http://tristate.apogee.net/)

Mercury Vapor (MV)

Mercury vapor lamps were developed to overcome problems with lamps for outdoor use and are now replaced with more efficient HPS and MH lamps. MV lamps are three times as efficient as incandescent lamps but are less efficient than fluorescent lamps and have an efficacy of only 25 to 50 lpw. HID lamps come in a wide variety of sizes and shapes and can be recognized by their bluish light cast. Dimming capabilities are available with a special ballast. MV lamps are commonly used in industrial and outdoor settings.

+ Inexpensive; long life of more than 24,000 hours.

- Low efficacy of 25 to 50; color rendering not as good as incandescent and fluorescent lamps; require five to seven minutes to attain full light output and four to five minutes of cooling and restart time; poor lumen maintenance; sensitive to voltage.

Metal Halide (MH)

Metal halide lamps are up to two times more efficient than MV lamps and six times more efficient than incandescent lamps, with an efficacy average from 70 to 115 lpw. Lamp life is in the range of 6,000 to 20,000 hours, which is short when compared to MV lamps. These lamps are often found in commercial and industrial settings, warehouses and outdoor security and sports lighting, where distinguishing colors is important. The decision between installing MH and fluorescent lamps can be a matter of mounting height required.

+ Best color rendering of all HID lamps.

- Two to five minutes of warm-up time and at least 10 minutes of cooling required; some must be operated in an enclosed fixture due to risk of breakage during failure.

High Pressure Sodium (HPS)

High pressure sodium lamps are the most efficient HID lamps, with an efficacy of 75 to 130 lpw. These lamps are seven times more efficient than incandescent and two times more efficient than MV. Common uses for HPS include streetlights and industrial plants.

+ Long life ranging from 10,000 to 24,000 hours; excellent lumen maintenance.

- Requires three to four minutes to reach full brightness and at least one minute of cool-down before restriking; golden-white light not good for all applications.

Low Pressure Sodium (LPS)

Low pressure sodium lamps are the most efficient light source commercially available and have a high efficacy of 130 to 185 lpw. The average life is 14,000 to 18,000 hours.

Most lamps will restart immediately after interruption of power supply but do require time to come to full brightness. LPS are commonly used for streets, highways, garages, automobile and train tunnels, and outdoor areas such as in security lighting and parking lots.

+ High efficacy; provides uniform light compared to other HID lamps; excellent lumen maintenance.

- Most expensive lamp type; monochromatic; requires the long time of seven to fifteen minutes to reach full light output; special disposal considerations, especially where water may be present.

Solid-State Lighting

In solid-state lighting, semiconducting material converts electricity directly into light without creating heat. This form of lighting can be as bright as incandescent lighting, is very energy efficient, and includes light-emitting diodes (LEDs) that have great potential as a cost-effective option in small area lighting such as task, shelf, decorative and pathway lighting as well as for use in stoplights and exit signs.